

What is claimed is:

1. A master tool for manufacturing a production tool useful to manufacture an abrasive article that comprises a major surface having deployed in fixed position thereon first and second three-dimensional abrasive composites, each of said composites comprising abrasive particles dispersed in a binder and having a shape defined by a substantially distinct and discernible boundary which includes substantially specific dimensions, wherein said first abrasive composite has a first shape having specific first dimensions and said second abrasive composite has a second shape having second specific dimensions, wherein each of said abrasive composites has a boundary defined by at least four planar surfaces wherein adjacent planar surfaces of one composite meet at an edge to define an angle of intersection therebetween, wherein at least one angle of intersection of said first abrasive composite is different from all of the angles of intersection of said second composite, said master tool comprising a structure having a major surface having a plurality of adjacent three-dimensional shapes projecting therefrom, wherein each three-dimensional shape is defined by a substantially distinct and discernible boundary which includes substantially specific dimensions, wherein a first three-dimensional shape has a first shape having specific first dimensions and a second three-dimensional shape has a second shape having second specific dimensions, wherein each of said three-dimensional shapes has a boundary defined by at least four planar surfaces wherein adjacent planar surfaces of one three-dimensional shape meet at an edge to define an angle of intersection therebetween, wherein at least one angle of intersection of said first three-dimensional shape is different from all angles of intersection of said second three-dimensional shape.

2. The master tool of claim 1, wherein said three-dimensional shapes comprise pyramids.

3. The master tool of claim 2, wherein each said pyramid comprises planar surfaces which intersect to form a material-included angle at a distal end of said pyramid, wherein said material-included angle is a value from 25° and 90°.

4. The master tool of claim 1, comprised of a metal material.

5. The master tool of claim 4, wherein said master tool surface is nickel-plated.

5 6. A master tool for manufacturing a production tool useful to shape an abrasive slurry into an array of three-dimensional nonidentical abrasive composites, said master tool having a major surface extending within a first imaginary plane, said master tool being made by a method comprising the steps of:

10 (1) determining angles corresponding to facing right and left planar surfaces of adjacent three-dimensional shapes and wherein each of said angles has a value as measured between its planar surface and a plane which extends in a normal direction to said major surface and contains an edge of said planar surface in contact with said major surface, by the following substeps:

15 (i) selecting an angle value between, but not including, 0° and 90° to establish a first right half angle of a first right planar surface of a first right-side three-dimensional shape with a random number generating means capable of randomly selecting an angle value between, but not including, 0° and 90° ;

20 (ii) selecting an angle value between, but not including, 0° and 90° with said random number generating means to establish a first left half angle for a first left planar surface of a first left-side three-dimensional shape facing said first right planar surface of said first right-side three-dimensional shape;

25 (iii) proceeding along a first direction extending linearly within said first imaginary plane to a second left planar surface of a second left-side three-dimensional shape located adjacent said first left-side three-dimensional shape and using said random number generating means to select a value between, but not including, 0° and 90° to establish a second left planar angle for said second left planar surface;

(iv) using said random number generating means to select a value between, but not including, 0° and 90° for a second right planar surface of a second right-side three-dimensional shape facing said second left planar surface;

30 (v) proceeding along said first direction to a third right-side three-dimensional shape located adjacent said second right-side three-dimensional shape;

(vi) repeating said substeps (i), (ii), (iii), (iv), and (v), in that sequence, at least once;

(2) repeating step (1) except that the angles are determined for left and right planar surfaces of adjacent three-dimensional shapes deployed in two adjacent rows in a second direction extending linearly within said first imaginary plane, wherein said first and second directions intersect;

(3) using means to determine, for a given width of said surface of said master, locations of grooves required to be cut by a cutting means to form a series of intersecting grooves defining a plurality of three-dimensional shapes having said angles calculated by steps (1) and (2); and

(4) providing a cutting means to cut grooves in said surface of said master in correspondence to said angles calculated by steps (1) and (2) and said groove locations determined by step (3) to form a series of intersecting grooves which define a plurality of three-dimensional shapes upraised from said surface, each of said shapes being defined by a distinct and discernible boundary including specific dimensions, wherein not all said three-dimensional shapes are identical.

7. The master tool of claim 6, wherein said right and left half angles each have a value between 8° and 45° .

8. The master tool of claim 6, wherein said three-dimensional shapes comprise pyramids.

9. The master tool of claim 6, wherein each said pyramid comprises planar surfaces which intersect to form a material-included angle at a distal end of said pyramid, wherein said material-included angle is a value from 25° and 90° .

10. The master tool of claim 6, wherein said cutting means comprises a diamond cutting tool.

11. The master tool of claim 6, comprised of a metal material.

12. The master tool of claim 6 wherein said major surface is nickel-plated after completing said step (4).

5 13. The master tool of claim 6, wherein said first and said second directions are oriented perpendicular to each other.

10 14. A production tool for manufacturing an abrasive article that comprises a major surface having deployed in fixed position thereon first and second three-dimensional abrasive composites, each of said composites comprising abrasive particles dispersed in a binder and having a shape defined by a substantially distinct and discernible boundary which includes substantially specific dimensions, wherein said first abrasive composite has a shape having specific first dimensions and said second abrasive composite has a second shape having second specific dimensions, wherein each of said abrasive composites has a boundary defined by at least four planar surfaces wherein adjacent planar surfaces of one composite meet at an edge to define an angle of intersection therebetween, wherein at least one angle of intersection of said first abrasive composite is different from all of the angles of intersection of said second composite, said production tool comprising a structure having a plurality of adjacent three-dimensional cavities form on a major surface thereof, wherein each three-dimensional cavity is defined by a substantially distinct and discernible boundary which includes substantially specific dimensions, wherein a first three-dimensional cavity has a first shape having specific first dimensions and a second three-dimensional cavity has a second shape having second specific dimensions, wherein each of said three-dimensional cavities has a boundary defined by at least four planar surfaces wherein adjacent planar surfaces of one three-dimensional cavity meet at an edge to define an angle of intersection therebetween, wherein at least one angle of intersection of said first three-dimensional cavity is different from all angles of intersection of said second three-dimensional cavity.

15 20 25 30 15. The production tool of claim 14, wherein said three-dimensional cavities comprise geometrical shapes.

16. The production tool of claim 15, wherein said geometrical shapes are selected from the group of geometrical shapes consisting of cubic, prismatic, pyramidal and truncated pyramidal shapes.

- 5 17. A production tool for manufacturing an abrasive article that comprises a major surface having deployed in fixed position thereon first and second three-dimensional abrasive composites, each of said composites comprising abrasive particles dispersed in a binder and having a shape defined by a substantially distinct and discernible boundary which includes substantially specific dimensions, wherein said first abrasive composite has a shape having specific first dimensions and said second abrasive composite has a second shape having second specific dimensions, wherein each of said abrasive composites has a boundary defined by at least four planar surfaces wherein adjacent planar surfaces of one composite meet at an edge to define an angle of intersection therebetween, wherein at least one angle of intersection of said first abrasive composite is different from all of the angles of intersection of said second composite, said production tool comprising a structure having a plurality of adjacent three-dimensional cavities form on a major surface thereof, wherein each three-dimensional cavity is defined by a substantially distinct and discernible boundary which includes substantially specific dimensions, wherein a first three-dimensional cavity has a first shape having specific first dimensions and a second three-dimensional cavity has a second shape having second specific dimensions, wherein each of said three-dimensional cavities has a boundary defined by at least four planar surfaces wherein adjacent planar surfaces of one three-dimensional cavity meet at an edge to define an angle of intersection therebetween, wherein at least one angle of intersection of said first three-dimensional cavity is different from all angles of intersection of said second three-dimensional cavity, wherein said three-dimensional cavities comprise pyramidal shapes, wherein each pyramidal shape comprises planar surfaces which intersect to form a material-included angle at a distal end of said pyramid, wherein said material-included angle is a value from 25° to 90°.
- 10
15
20
25
30

18. The production tool of claim 14, comprised of a material selected from the group consisting of metal, metal alloy and plastic.

19. A production tool useful to shape an abrasive slurry into an array of three-dimensional nonidentical abrasive composites, said production tool
5 manufactured by a method comprising:

(A) preparing a master tool, the method comprising:

(1) determining angles corresponding to facing right and left planar surfaces of adjacent three-dimensional shapes and wherein each of said
10 angles has a value as measured between its planar surface and a plane which extends in a normal direction to said major surface and contains an edge of said planar surface in contact with said major surface, by the following substeps:

(i) selecting an angle value between, but not including, 0° and 90° to establish a first right half angle of a first right planar
15 surface of a first right-side three-dimensional shape with a random number generating means capable of randomly selecting an angle value between, but not including, 0° and 90° ;

(ii) selecting an angle value between, but not including, 0° and 90° with said random number generating means to establish a
20 first left half angle for a first left planar surface of a first left-side three-dimensional shape facing said first right planar surface of said first right-side three-dimensional shape;

(iii) proceeding along a first direction extending linearly within said first imaginary plane to a second left planar surface of a
25 second left-side three-dimensional shape located adjacent said first left-side three-dimensional shape and using said random number generating means to select a value between, but not including, 0° and 90° to establish a second left planar angle for said second left planar surface;

(iv) using said random number generating means to
30 select a value between, but not including, 0° and 90° for a second right planar surface of a second right-side three-dimensional shape facing said second left planar surface;

(v) proceeding along said first direction to a third right-side three-dimensional shape located adjacent said second right-side three-dimensional shape;

(vi) repeating said substeps (i), (ii), (iii), (iv), and (v),
5 in that sequence, at least once;

(2) repeating step (1) except that the angles are determined for left and right planar surfaces of adjacent three-dimensional shapes deployed in two adjacent rows in a second direction extending linearly within said first imaginary plane, wherein said first and second directions intersect;

10 (3) using means to determine, for a given width of said surface of said master tool, locations of grooves required to be cut by a cutting means to form a series of intersecting grooves defining a plurality of three-dimensional shapes having said angles calculated by steps (1) and (2); and

(4) providing a cutting means to cut grooves in said surface of said
15 master tool in correspondence to said angles calculated by steps (1) and (2) and said groove locations determined by step (3) to form a series of intersecting grooves which define a plurality of three-dimensional shapes upraised from said surface, each of said shapes being defined by a distinct and discernible boundary including specific dimensions, wherein not all said three-dimensional shapes are identical;
20 and

(B) forming a production tool using the master tool.

20. A production tool for manufacturing an abrasive article that comprises a major surface having deployed in fixed position thereon first and second three-
25 dimensional abrasive composites, each of said composites comprising abrasive particles dispersed in a binder and having a shape defined by a substantially distinct and discernible boundary which includes substantially specific dimensions, wherein said first abrasive composite has a shape having specific first dimensions and said second abrasive composite has a second shape having
30 second specific dimensions, wherein each of said abrasive composites has a boundary defined by at least four planar surfaces wherein adjacent planar surfaces of one composite meet at an edge to define an angle of intersection therebetween, wherein at least one angle of intersection of said first abrasive

composite is different from all of the angles of intersection of said second composite, said production tool comprising a structure having a plurality of adjacent three-dimensional cavities form on a major surface thereof, wherein each three-dimensional cavity is defined by a substantially distinct and discernible boundary which includes substantially specific dimensions, wherein a first three-dimensional cavity has a first shape having specific first dimensions and a second three-dimensional cavity has a second shape having second specific dimensions, wherein each of said three-dimensional cavities has a boundary defined by at least four planar surfaces wherein adjacent planar surfaces of one three-dimensional cavity meet at an edge to define an angle of intersection therebetween, wherein at least one angle of intersection of said first three-dimensional cavity is different from all angles of intersection of said second three-dimensional cavity, and wherein the production tool is a roll.

21. A production tool for manufacturing an abrasive article that comprises a major surface having deployed in fixed position thereon first and second three-dimensional abrasive composites, each of said composites comprising abrasive particles dispersed in a binder and having a shape defined by a substantially distinct and discernible boundary which includes substantially specific dimensions, wherein said first abrasive composite has a shape having specific first dimensions and said second abrasive composite has a second shape having second specific dimensions, wherein each of said abrasive composites has a boundary defined by at least four planar surfaces wherein adjacent planar surfaces of one composite meet at an edge to define an angle of intersection therebetween, wherein at least one angle of intersection of said first abrasive composite is different from all of the angles of intersection of said second composite, said production tool comprising a structure having a plurality of adjacent three-dimensional cavities form on a major surface thereof, wherein each three-dimensional cavity is defined by a substantially distinct and discernible boundary which includes substantially specific dimensions, wherein a first three-dimensional cavity has a first shape having specific first dimensions and a second three-dimensional cavity has a second shape having second specific dimensions, wherein each of said three-dimensional cavities has a

boundary defined by at least four planar surfaces wherein adjacent planar surfaces of one three-dimensional cavity meet at an edge to define an angle of intersection therebetween, wherein at least one angle of intersection of said first three-dimensional cavity is different from all angles of intersection of said second three-dimensional cavity, and wherein the production tool is a coating roll.

22. A production tool suitable for use in manufacturing an abrasive article comprising a first and second plurality of cavities, wherein the first plurality of cavities each have a first geometric shape and first plurality of angles forming the geometric shape and the second plurality of cavities each have a second geometric shape and second plurality of angles forming the geometric shape, and wherein at least one of the angles of the first plurality is different from all of the angles of the second plurality of angles.

23. A production tool suitable for use in manufacturing an abrasive article comprising a first, second, and third plurality of cavities, wherein the first plurality of cavities each have a first geometric shape and first plurality of angles forming the geometric shape, the second plurality of cavities each have a second geometric shape and second plurality of angles forming the geometric shape, and the third plurality of cavities each have a third geometric shape and third plurality of angles forming the geometric shape, wherein at least one of the angles of the first plurality is different from all of the angles of the second and third plurality of angles, and wherein at least one of the angles of the second plurality is different from all of the angles of the first and third plurality of angles.

24. A production tool suitable for use in manufacturing an abrasive article comprising a first, second, third, and fourth plurality of cavities, wherein the first plurality of cavities each have a first geometric shape and first plurality of angles forming the geometric shape, the second plurality of cavities each have a second geometric shape and second plurality of angles forming the geometric shape, the third plurality of cavities each have a third geometric shape and third plurality of angles forming the geometric shape, and the fourth plurality of cavities each have a

fourth geometric shape and fourth plurality of angles forming the geometric shape, wherein at least one of the angles of the first plurality is different from all of the angles of the second, third, and fourth plurality of angles, wherein at least one of the angles of the second plurality is different from all of the angles of the first, third, and fourth plurality of angles, and wherein at least one of the angles of the third plurality is different from all of the angles of the first, second, and fourth plurality of angles.

25. A production tool suitable for use in manufacturing an abrasive article comprising a plurality of cavities, wherein the cavities each have dimensions defining the cavity, and wherein at least 10% of pairs of adjacent cavities have at least one dimension different between the two cavities of the pair.

26. A production tool suitable for use in manufacturing an abrasive article comprising a plurality of cavities, wherein the cavities each have dimensions defining the cavity, and wherein at least 30% of pairs of adjacent cavities have at least one dimension different between the two cavities of the pair.

27. A production tool suitable for use in manufacturing an abrasive article comprising a plurality of cavities, wherein the cavities each have dimensions defining the cavity, and wherein at least 50% of pairs of adjacent cavities have at least one dimension different between the two cavities of the pair.

28. A production tool suitable for use in manufacturing an abrasive article comprising a plurality of cavities, wherein the cavities each have a geometric shape, dimensions defining the cavity, and angles forming the geometric shape, wherein the angles are different in at least two of the cavities, and further wherein at least 10% of pairs of adjacent cavities have at least one dimension different between the two cavities of the pair.

30

29. A production tool suitable for use in manufacturing an abrasive article comprising a plurality of cavities, wherein the cavities each have dimensions

defining the cavity, and wherein at least two adjacent cavities have at least one dimension different between the two cavities.

30. A production tool suitable for use in manufacturing an abrasive article
5 comprising a plurality of cavities defining at least a first, a second, and a third group, wherein a first group of cavities has a first shape, a second group of cavities has a second shape, a third group of cavities has a third shape, and wherein the first, second, and third shapes are all different.

10 31. A production tool suitable for use in manufacturing an abrasive article comprising a plurality of cavities defining at least a first, a second, and a third group, wherein a first group of cavities has a first size, a second group of cavities has a second size, a third group of cavities has a third size, and wherein the first, second, and third sizes are all different.

15 32. A production tool suitable for use in manufacturing an abrasive article comprising a plurality of cavities defined by substantially distinct and discernible boundaries which include substantially specific dimensions, wherein a first cavity has specific first dimensions, a second cavity has specific second dimensions, and a
20 third cavity has specific third dimensions, each of said cavities has a boundary defined by at least four planar surfaces wherein adjacent planar surfaces of one cavity meet at an edge to define an angle of intersection therebetween, wherein at least one angle of intersection of said first cavity is different from all the angles of intersection of said second and third cavities, and wherein at least one angle of
25 intersection of said second cavity is different from all the angles of intersection of said first and third cavities.

33. A production tool suitable for use in manufacturing an abrasive article
30 comprising a first and second plurality of cavities, wherein the first plurality of cavities each have a first geometric shape and first plurality of angles forming the geometric shape and the second plurality of cavities each have a second geometric shape and second plurality of angles forming the geometric shape, wherein at least

one of the angles of the first plurality is different from all of the angles of the second plurality of angles, and wherein the production tool is a coating roll.

34. A production tool suitable for use in manufacturing an abrasive article
5 comprising a first, second, and third plurality of cavities, wherein the first plurality
of cavities each have a first geometric shape and first plurality of angles forming the
geometric shape, the second plurality of cavities each have a second geometric
shape and second plurality of angles forming the geometric shape, and the third
10 plurality of cavities each have a third geometric shape and third plurality of angles
forming the geometric shape, wherein at least one of the angles of the first plurality
is different from all of the angles of the second and third plurality of angles,
wherein at least one of the angles of the second plurality is different from all of the
angles of the first and third plurality of angles, and wherein the production tool is a
coating roll.

35. A production tool suitable for use in manufacturing an abrasive article
comprising a first, second, third, and fourth plurality of cavities, wherein the first
plurality of cavities each have a first geometric shape and first plurality of angles
forming the geometric shape, the second plurality of cavities each have a second
20 geometric shape and second plurality of angles forming the geometric shape, the
third plurality of cavities each have a third geometric shape and third plurality of
angles forming the geometric shape, and the fourth plurality of cavities each have a
fourth geometric shape and fourth plurality of angles forming the geometric shape,
wherein at least one of the angles of the first plurality is different from all of the
25 angles of the second, third, and fourth plurality of angles, wherein at least one of the
angles of the second plurality is different from all of the angles of the first, third,
and fourth plurality of angles, wherein at least one of the angles of the third
plurality is different from all of the angles of the first, second, and fourth plurality
of angles, and wherein the production tool is a coating roll.

36. A production tool suitable for use in manufacturing an abrasive article
comprising a plurality of cavities, wherein the cavities each have dimensions
defining the cavity, wherein at least 10% of pairs of adjacent cavities have at least

one dimension different between the two cavities of the pair, and wherein the production tool is a coating roll.

37. A production tool suitable for use in manufacturing an abrasive article comprising a plurality of cavities, wherein the cavities each have dimensions defining the cavity, wherein at least 30% of pairs of adjacent cavities have at least one dimension different between the two cavities of the pair, and wherein the production tool is a coating roll.

38. A production tool suitable for use in manufacturing an abrasive article comprising a plurality of cavities, wherein the cavities each have dimensions defining the cavity, wherein at least 50% of pairs of adjacent cavities have at least one dimension different between the two cavities of the pair, and wherein the production tool is a coating roll.

39. A production tool suitable for use in manufacturing an abrasive article comprising a plurality of cavities, wherein the cavities each have a geometric shape, dimensions defining the cavity, and angles forming the geometric shape, wherein the angles are different in at least two of the cavities, wherein at least 10% of pairs of adjacent cavities have at least one dimension different between the two cavities of the pair, and wherein the production tool is a coating roll.

40. A production tool suitable for use in manufacturing an abrasive article comprising a plurality of cavities, wherein the cavities each have dimensions defining the cavity, wherein at least two adjacent cavities have at least one dimension different between the two cavities, and wherein the production tool is a coating roll.

41. A production tool suitable for use in manufacturing an abrasive article comprising a plurality of cavities defining at least a first and a second group, wherein a first group of cavities has a first shape and a second group of cavities has a second, different, shape, and wherein the production tool is a coating roll.

42. A production tool suitable for use in manufacturing an abrasive article comprising a plurality of cavities defining at least a first and a second group, wherein a first group of cavities has a first size and a second group of cavities has a second, different, size, and wherein the production tool is a coating roll.

5

43. A production tool suitable for use in manufacturing an abrasive article comprising a plurality of cavities defined by substantially distinct and discernible boundaries which include substantially specific dimensions, wherein a first cavity has specific first dimensions and a second cavity has specific second dimensions, each of said cavities has a boundary defined by at least four planar surfaces wherein adjacent planar surfaces of one cavity meet at an edge to define an angle of intersection therebetween, wherein at least one angle of intersection of said first cavity is different from all the angles of intersection of said second cavity, and wherein the production tool is a coating roll.

10

15

44. A production tool suitable for use in manufacturing an abrasive article comprising a first and second plurality of cavities, wherein the first plurality of cavities each have a first geometric shape and first plurality of angles forming the geometric shape and the second plurality of cavities each have a second geometric shape and second plurality of angles forming the geometric shape, wherein at least one of the angles of the first plurality is different from all of the angles of the second plurality of angles, and wherein the production tool is an engraved metal roll.

20

25

45. A production tool suitable for use in manufacturing an abrasive article comprising a first, second, and third plurality of cavities, wherein the first plurality of cavities each have a first geometric shape and first plurality of angles forming the geometric shape, the second plurality of cavities each have a second geometric shape and second plurality of angles forming the geometric shape, and the third plurality of cavities each have a third geometric shape and third plurality of angles forming the geometric shape, wherein at least one of the angles of the first plurality is different from all of the angles of the second and third plurality of angles, wherein at least one of the angles of the second plurality is different from all of the

30

angles of the first and third plurality of angles, and wherein the production tool is an engraved metal roll.

46. A production tool suitable for use in manufacturing an abrasive article
5 comprising a first, second, third, and fourth plurality of cavities, wherein the first
plurality of cavities each have a first geometric shape and first plurality of angles
forming the geometric shape, the second plurality of cavities each have a second
geometric shape and second plurality of angles forming the geometric shape, the
10 third plurality of cavities each have a third geometric shape and third plurality of
angles forming the geometric shape, and the fourth plurality of cavities each have a
fourth geometric shape and fourth plurality of angles forming the geometric shape,
wherein at least one of the angles of the first plurality is different from all of the
angles of the second, third, and fourth plurality of angles, wherein at least one of the
15 angles of the second plurality is different from all of the angles of the first, third,
and fourth plurality of angles, wherein at least one of the angles of the third
plurality is different from all of the angles of the first, second, and fourth plurality
of angles, and wherein the production tool is an engraved metal roll.

47. A production tool suitable for use in manufacturing an abrasive article
20 comprising a plurality of cavities, wherein the cavities each have dimensions
defining the cavity, wherein at least 10% of pairs of adjacent cavities have at least
one dimension different between the two cavities of the pair, and wherein the
production tool is an engraved metal roll.

25 48. A production tool suitable for use in manufacturing an abrasive article
comprising a plurality of cavities, wherein the cavities each have dimensions
defining the cavity, wherein at least 30% of pairs of adjacent cavities have at least
one dimension different between the two cavities of the pair, and wherein the
production tool is an engraved metal roll.

30 49. A production tool suitable for use in manufacturing an abrasive article
comprising a plurality of cavities, wherein the cavities each have dimensions
defining the cavity, wherein at least 50% of pairs of adjacent cavities have at least

one dimension different between the two cavities of the pair, and wherein the production tool is an engraved metal roll.

50. A production tool suitable for use in manufacturing an abrasive article
 5 comprising a plurality of cavities, wherein the cavities each have a geometric shape, dimensions defining the cavity, and angles forming the geometric shape, wherein the angles are different in at least two of the cavities, wherein at least 10% of pairs of adjacent cavities have at least one dimension different between the two cavities of the pair, and wherein the production tool is an engraved metal roll.

10

51. A production tool suitable for use in manufacturing an abrasive article
 comprising a plurality of cavities, wherein the cavities each have dimensions defining the cavity, wherein at least two adjacent cavities have at least one dimension different between the two cavities, and wherein the production tool is an
 15 engraved metal roll.

52. A production tool suitable for use in manufacturing an abrasive article
 comprising a plurality of cavities defining at least a first and a second group, wherein a first group of cavities has a first shape and a second group of cavities has
 20 a second, different, shape, and wherein the production tool is an engraved metal roll.

53. A production tool suitable for use in manufacturing an abrasive article
 comprising a plurality of cavities defining at least a first and a second group,
 25 wherein a first group of cavities has a first size and a second group of cavities has a second, different, size, and wherein the production tool is an engraved metal roll.

54. A production tool suitable for use in manufacturing an abrasive article
 comprising a plurality of cavities defined by substantially distinct and discernible
 30 boundaries which include substantially specific dimensions, wherein a first cavity has specific first dimensions and a second cavity has specific second dimensions, each of said cavities has a boundary defined by at least four planar surfaces wherein adjacent planar surfaces of one cavity meet at an edge to define an angle of

intersection therebetween, wherein at least one angle of intersection of said first cavity is different from all the angles of intersection of said second cavity, and wherein the production tool is an engraved metal roll.

- 5 55. A method of making a production tool, the method comprising:
creating a design for a production tool for manufacturing an abrasive article,
the production tool comprising a first and second plurality of cavities, wherein the
first plurality of cavities each have a first geometric shape and first plurality of
angles forming the geometric shape and the second plurality of cavities each have a
10 second geometric shape and second plurality of angles forming the geometric
shape, wherein at least one of the angles of the first plurality is different from all of
the angles of the second plurality of angles; and
forming the production tool using the design.

- 15 56. A method of making a production tool, the method comprising:
creating a design for a production tool for manufacturing an abrasive article,
the production tool comprising a first, second, and third plurality of cavities,
wherein the first plurality of cavities each have a first geometric shape and first
plurality of angles forming the geometric shape, the second plurality of cavities
20 each have a second geometric shape and second plurality of angles forming the
geometric shape, and the third plurality of cavities each have a third geometric
shape and third plurality of angles forming the geometric shape, wherein at least
one of the angles of the first plurality is different from all of the angles of the
second and third plurality of angles, and wherein at least one of the angles of the
25 second plurality is different from all of the angles of the first and third plurality of
angles; and
forming the production tool using the design.

57. A method of making a production tool, the method comprising:
30 creating a design for a production tool for manufacturing an abrasive article,
the production tool comprising a first, second, third, and fourth plurality of cavities,
wherein the first plurality of cavities each have a first geometric shape and first
plurality of angles forming the geometric shape, the second plurality of cavities

each have a second geometric shape and second plurality of angles forming the geometric shape, the third plurality of cavities each have a third geometric shape and third plurality of angles forming the geometric shape, and the fourth plurality of cavities each have a fourth geometric shape and fourth plurality of angles forming the geometric shape, wherein at least one of the angles of the first plurality is different from all of the angles of the second, third, and fourth plurality of angles, wherein at least one of the angles of the second plurality is different from all of the angles of the first, third, and fourth plurality of angles, and wherein at least one of the angles of the third plurality is different from all of the angles of the first, second, and fourth plurality of angles; and
forming the production tool using the design.

58. A method of making a production tool, the method comprising:
creating a design for a production tool for manufacturing an abrasive article, the production tool comprising a plurality of cavities, wherein the cavities each have dimensions defining the cavity, and wherein at least 10% of pairs of adjacent cavities have at least one dimension different between the two cavities of the pair; and
forming the production tool using the design.

59. A method of making a production tool, the method comprising:
creating a design for a production tool for manufacturing an abrasive article, the production tool comprising a plurality of cavities, wherein the cavities each have dimensions defining the cavity, and wherein at least 30% of pairs of adjacent cavities have at least one dimension different between the two cavities of the pair; and
forming the production tool using the design.

60. A method of making a production tool, the method comprising:
creating a design for a production tool for manufacturing an abrasive article, the production tool comprising a plurality of cavities, wherein the cavities each have dimensions defining the cavity, and wherein at least 50% of pairs of adjacent

cavities have at least one dimension different between the two cavities of the pair;
and

forming the production tool using the design.

- 5 61. A method of making a production tool, the method comprising:
creating a design for a production tool for manufacturing an abrasive article,
the production tool comprising a plurality of cavities, wherein the cavities each
have a geometric shape, dimensions defining the cavity, and angles forming the
geometric shape, wherein the angles are different in at least two of the cavities, and
10 further wherein at least 10% of pairs of adjacent cavities have at least one
dimension different between the two cavities of the pair; and
forming the production tool using the design.

- 15 62. A method of making a production tool, the method comprising:
creating a design for a production tool for manufacturing an abrasive article,
the production tool comprising a plurality of cavities, wherein the cavities each
have dimensions defining the cavity, and wherein at least two adjacent cavities have
at least one dimension different between the two cavities; and
forming the production tool using the design.

- 20 63. A method of making a production tool, the method comprising:
creating a design for a production tool for manufacturing an abrasive article,
the production tool comprising a plurality of cavities defining at least a first, a
second group, and a third group, wherein a first group of cavities has a first shape, a
25 second group of cavities has a second shape, a third group of cavities has a third
shape, and wherein the first, second, and third shapes are all different; and
forming the production tool using the design.

- 30 64. A method of making a production tool, the method comprising:
creating a design for a production tool for manufacturing an abrasive article, the
production tool comprising a plurality of cavities defining at least a first, a second
group, and a third group, wherein a first group of cavities has a first size, a second

group of cavities has a second size, a third group of cavities has a third size, and wherein the first, second, and third sizes are all different; and forming the production tool using the design.

- 5 65. A method of making a production tool, the method comprising:
creating a design for a production tool for manufacturing an abrasive article,
the production tool comprising a plurality of cavities defined by substantially
distinct and discernible boundaries which include substantially specific dimensions,
wherein a first cavity has specific first dimensions and a second cavity has specific
10 second dimensions, and further wherein each of said cavities has a boundary
defined by at least four planar surfaces wherein adjacent planar surfaces of one
cavity meet at an edge to define an angle of intersection therebetween, wherein at
least one angle of intersection of said first cavity is different from all the angles of
intersection of said second cavity; and
15 forming the production tool using the design.

66. The method of claim 55, wherein the production tool is a coating roll.

67. The method of claim 56, wherein the production tool is a coating roll.

20

68. The method of claim 57, wherein the production tool is a coating roll.

69. The method of claim 58, wherein the production tool is a coating roll.

25

70. The method of claim 59, wherein the production tool is a coating roll.

71. The method of claim 60, wherein the production tool is a coating roll.

72. The method of claim 61, wherein the production tool is a coating roll.

30

73. The method of claim 62, wherein the production tool is a coating roll.

74. The method of claim 63, wherein the production tool is a coating roll.

75. The method of claim 64, wherein the production tool is a coating roll.
76. The method of claim 65, wherein the production tool is a coating roll.
- 5 77. The method of claim 55, wherein the production tool is an engraved metal roll.
78. The method of claim 56, wherein the production tool is an engraved metal
10 roll.
79. The method of claim 57, wherein the production tool is an engraved metal roll.
- 15 80. The method of claim 58, wherein the production tool is an engraved metal roll.
81. The method of claim 59, wherein the production tool is an engraved metal roll.
- 20 82. The method of claim 60, wherein the production tool is an engraved metal roll.
83. The method of claim 61, wherein the production tool is an engraved metal
25 roll.
84. The method of claim 62, wherein the production tool is an engraved metal roll.
- 30 85. The method of claim 63, wherein the production tool is an engraved metal roll.

86. The method of claim 64, wherein the production tool is an engraved metal roll.

87. The method of claim 65, wherein the production tool is an engraved metal
5 roll.

88. The production tool of claim 22, wherein the first geometric shape includes a base and first plurality of base edge lengths, wherein the second geometric shape includes a base and second plurality of base edge lengths, and wherein at least one of the base edge lengths of the first plurality is different from all of the base edge lengths of the second plurality of base edge lengths.

89. The production tool of claim 23, wherein the first geometric shape includes a base and first plurality of base edge lengths, wherein the second geometric shape includes a base and second plurality of base edge lengths, wherein the third geometric shape includes a base and third plurality of base edge lengths, wherein at least one of the base edge lengths of the first plurality is different from all of the base edge lengths of the second and third plurality of base edge lengths, and wherein at least one of the base edge lengths of the second plurality is different from all of the base edge lengths of the first and third plurality of base edge lengths.

90. The production tool of claim 24, wherein the first geometric shape includes a base and first plurality of base edge lengths, wherein the second geometric shape includes a base and second plurality of base edge lengths, wherein the third
25 geometric shape includes a base and third plurality of base edge lengths, wherein the fourth geometric shape includes a base and fourth plurality of base edge lengths, wherein at least one of the base edge lengths of the first plurality is different from all of the base edge lengths of the second, third, and fourth plurality of base edge
30 lengths, wherein at least one of the base edge lengths of the second plurality is different from all of the base edge lengths of the first, third, and fourth plurality of base edge lengths, and wherein at least one of the base edge lengths of the third plurality is different from all of the base edge lengths of the first, second, and fourth plurality of base edge lengths.

91. A production tool suitable for use in manufacturing an abrasive article comprising a first and second plurality of cavities, wherein the first plurality of cavities each have a first geometric shape including a base and first plurality of base edge lengths forming the base of the geometric shape and the second plurality of cavities each have a second geometric shape including a base and second plurality of base edge lengths forming the base of the geometric shape, and wherein at least one of the base edge lengths of the first plurality is different from all of the base edge lengths of the second plurality of base edge lengths.

10

92. A production tool suitable for use in manufacturing an abrasive article comprising a first, second, and third plurality of cavities, wherein the first plurality of cavities each have a first geometric shape including a base and first plurality of base edge lengths forming the base of the geometric shape, the second plurality of cavities each have a second geometric shape including a base and second plurality of base edge lengths forming the base of the geometric shape, and the third plurality of cavities each have a third geometric shape including a base and third plurality of base edge lengths forming the base of the geometric shape, wherein at least one of the base edge lengths of the first plurality is different from all of the base edge lengths of the second and third plurality of base edge lengths, and wherein at least one of the base edge lengths of the second plurality is different from all of the base edge lengths of the first and third plurality of base edge lengths.

93. A production tool suitable for use in manufacturing an abrasive article comprising a first, second, third, and fourth plurality of cavities, wherein the first plurality of cavities each have a first geometric shape including a base and first plurality of base edge lengths forming the base of the geometric shape, the second plurality of cavities each have a second geometric shape including a base and second plurality of base edge lengths forming the base of the geometric shape, the third plurality of cavities each have a third geometric shape including a base and third plurality of base edge lengths forming the base of the geometric shape, and the fourth plurality of cavities each have a fourth geometric shape including a base and fourth plurality of base edge lengths forming the base of the geometric shape,

wherein at least one of the base edge lengths of the first plurality is different from all of the base edge lengths of the second, third, and fourth plurality of base edge lengths, wherein at least one of the base edge lengths of the second plurality is different from all of the base edge lengths of the first, third, and fourth plurality of base edge lengths, and wherein at least one of the base edge lengths of the third plurality is different from all of the base edge lengths of the first, second, and fourth plurality of base edge lengths.

94. A production tool suitable for use in manufacturing an abrasive article comprising a plurality of cavities, wherein the cavities each have dimensions defining the cavity, the dimensions including base edge lengths, and wherein at least 10% of pairs of adjacent cavities have at least one base edge length different between the two cavities of the pair.

95. A production tool suitable for use in manufacturing an abrasive article comprising a plurality of cavities, wherein the cavities each have dimensions defining the cavity, the dimensions including base edge lengths, and wherein at least 30% of pairs of adjacent cavities have at least one base edge length different between the two cavities of the pair.

96. A production tool suitable for use in manufacturing an abrasive article comprising a plurality of cavities, wherein the cavities each have dimensions defining the cavity, the dimensions including base edge lengths, and wherein at least 50% of pairs of adjacent cavities have at least one base edge length different between the two cavities of the pair.

97. A production tool suitable for use in manufacturing an abrasive article comprising a plurality of cavities, wherein the cavities each have dimensions defining the cavity, the dimensions including base edge lengths, and wherein at least two adjacent cavities have at least one base edge lengths different between the two cavities.

98. The production tool of claim 91 which is a coating roll.

99. The production tool of claim 92 which is a coating roll.

100. The production tool of claim 93 which is a coating roll.

5 101. The production tool of claim 94 which is a coating roll.

102. The production tool of claim 95 which is a coating roll.

10 103. The production tool of claim 96 which is a coating roll.

104. The production tool of claim 97 which is a coating roll.

105. The production tool of claim 91 which is an engraved metal roll.

15 106. The production tool of claim 92 which is an engraved metal roll.

107. The production tool of claim 93 which is an engraved metal roll.

20 108. The production tool of claim 94 which is an engraved metal roll.

109. The production tool of claim 95 which is an engraved metal roll.

110. The production tool of claim 96 which is an engraved metal roll.

25 111. The production tool of claim 97 which is an engraved metal roll.

112. A method of making a production tool, the method comprising:
creating a design for a production tool for manufacturing an abrasive article,
30 the production tool comprising a first and second plurality of cavities, wherein the
first plurality of cavities each have a first geometric shape including a base and first
plurality of base edge lengths forming the base of the geometric shape and the
second plurality of cavities each have a second geometric shape including a base

and second plurality of base edge lengths forming the base of the geometric shape, and wherein at least one of the base edge lengths of the first plurality is different from all of the base edge lengths of the second plurality of base edge lengths; and forming the production tool using the design.

5

113. A method of making a production tool, the method comprising:

creating a design for a production tool for manufacturing an abrasive article, the production tool comprising a first, second, and third plurality of cavities, wherein the first plurality of cavities each have a first geometric shape including a base and first plurality of base edge lengths forming the base of the geometric shape, the second plurality of cavities each have a second geometric shape including a base and second plurality of base edge lengths forming the base of the geometric shape, and the third plurality of cavities each have a third geometric shape including a base and third plurality of base edge lengths forming the base of the geometric shape, wherein at least one of the base edge lengths of the first plurality is different from all of the base edge lengths of the second and third plurality of base edge lengths, and wherein at least one of the base edge lengths of the second plurality is different from all of the base edge lengths of the first and third plurality of base edge lengths; and forming the production tool using the design.

20

114. A method of making a production tool, the method comprising:

creating a design for a production tool for manufacturing an abrasive article, the production tool comprising a first, second, third, and fourth plurality of cavities, wherein the first plurality of cavities each have a first geometric shape including a base and first plurality of base edge lengths forming the base of the geometric shape, the second plurality of cavities each have a second geometric shape including a base and second plurality of base edge lengths forming the base of the geometric shape, the third plurality of cavities each have a third geometric shape including a base and third plurality of base edge lengths forming the base of the geometric shape, and the fourth plurality of cavities each have a fourth geometric shape including a base and fourth plurality of base edge lengths forming the base of the geometric shape, wherein at least one of the base edge lengths of the first plurality is different from all of the base edge lengths of the second, third, and fourth plurality of base edge

lengths, wherein at least one of the base edge lengths of the second plurality is different from all of the base edge lengths of the first, third, and fourth plurality of base edge lengths, and wherein at least one of the base edge lengths of the third plurality is different from all of the base edge lengths of the first, second, and fourth plurality of base edge lengths; and
5 forming the production tool using the design.

115. A method of making a production tool, the method comprising:
creating a design for a production tool for manufacturing an abrasive article,
10 the production tool comprising a plurality of cavities, wherein the cavities each have dimensions defining the cavity, the dimensions including base edge lengths wherein at least 10% of pairs of adjacent cavities have at least one base edge length different between the two cavities of the pair; and
forming the production tool using the design.

15
116. A method of making a production tool, the method comprising:
creating a design for a production tool for manufacturing an abrasive article,
the production tool comprising a plurality of cavities, wherein the cavities each have dimensions defining the cavity, the dimensions including base edge lengths
20 wherein at least 30% of pairs of adjacent cavities have at least one base edge length different between the two cavities of the pair; and
forming the production tool using the design.

117. A method of making a production tool, the method comprising:
25 creating a design for a production tool for manufacturing an abrasive article,
the production tool comprising a plurality of cavities, wherein the cavities each have dimensions defining the cavity, the dimensions including base edge lengths wherein at least 50% of pairs of adjacent cavities have at least one base edge length different between the two cavities of the pair; and
30 forming the production tool using the design.

118. A method of making a production tool, the method comprising:

creating a design for a production tool for manufacturing an abrasive article,
the production tool comprising a plurality of cavities, wherein the cavities each
have dimensions defining the cavity, the dimensions including base edge lengths,
and wherein at least two adjacent cavities have at least one base edge lengths
5 different between the two cavities; and
forming the production tool using the design.

119. The method of claim 112, wherein the production tool is a coating roll.

10 120. The method of claim 113, wherein the production tool is a coating roll.

121. The method of claim 114, wherein the production tool is a coating roll.

122. The method of claim 115, wherein the production tool is a coating roll.

15

123. The method of claim 116, wherein the production tool is a coating roll.

124. The method of claim 117, wherein the production tool is a coating roll.

20

125. The method of claim 118, wherein the production tool is a coating roll.

126. The method of claim 112, wherein the production tool is an engraved metal
roll.

25 127. The method of claim 113, wherein the production tool is an engraved metal
roll.

128. The method of claim 114, wherein the production tool is an engraved metal
roll.

30

129. The method of claim 115, wherein the production tool is an engraved metal
roll.

130. The method of claim 116, wherein the production tool is an engraved metal roll.

131. The method of claim 117, wherein the production tool is an engraved metal
5 roll.

132. The method of claim 118, wherein the production tool is an engraved metal roll.

10 133. The production tool of claim 92, wherein at least one of the base edge lengths of the third plurality of base edge lengths is different from all the base edge lengths of the first and second plurality of base edge lengths.

134. The production tool of claim 92, wherein the first, second, and third
15 geometric shapes are pyramidal.

135. The production tool of claim 92, wherein the first, second, and third geometric shapes are truncated pyramidal.

20 136. A production tool suitable for use in manufacturing an abrasive article comprising a first, second, and third row of cavities, wherein the cavities each have a geometric shape including a base and a plurality of base edge lengths forming the base of the geometric shape, wherein at least one of the base edge lengths of the first row of cavities is different from all the base edge lengths of the second and
25 third rows of cavities, and wherein at least one of the base edge lengths of the second row of cavities is different from all the base edge lengths of the first and third row of cavities.

137. The production tool of claim 136, wherein at least one of the base edge
30 lengths of the third row of cavities is different from all the base edge lengths of the first and second row of cavities.

138. The production tool of claim 136, wherein the geometric shape of the cavities in the first, second, and third rows are pyramidal.

139. The production tool of claim 136, wherein the geometric shape of the
5 cavities in the first, second, and third rows are truncated pyramidal.

140. The production tool of claim 136, wherein the first, second, and third rows of cavities extend in parallel to one another.

10 141. The production tool of claim 136, wherein the base edge lengths of the first row of cavities have a first base edge length extending parallel to the first row and a second base edge length extending perpendicular to the first row, and wherein the second base length of all the cavities in the first row is the same.

15 142. The production tool of claim 141, wherein at least some of the first base lengths of the cavities in the first row are different from one another.

143. A production tool suitable for use in manufacturing an abrasive article comprising first, second, and third cavities, wherein the first cavity has a first
20 geometric shape including a base and a first plurality of base edge lengths forming the base of the geometric shape, the second cavity has a second geometric shape including a base and a second plurality of base edge lengths forming the base of the geometric shape, and the third cavity has a third geometric shape including a base and a third plurality of base edge lengths forming the base of the geometric shape,
25 wherein at least one of the base edge lengths of the first plurality of base edge lengths is different from all the base edge lengths of the second and third plurality of base edge lengths, and wherein at least one of the base edge lengths of the second plurality of base edge lengths is different from all the base edge lengths of the first and third plurality of base edge lengths.

30

144. The production tool of claim 143, wherein at least one of the base edge lengths of the third plurality of base edge lengths is different from all the base edge lengths of the first and second plurality of base edge lengths.

145. The production tool of claim 143, wherein the geometric shapes of the first, second, and third cavities are pyramidal.

5 146. The production tool of claim 143, wherein the geometric shapes of the first, second, and third cavities are truncated pyramidal.

147. The production tool of claim 143, wherein the first cavity is located adjacent to the second cavity.

10

148. The production tool of claim 147, wherein the second cavity is located adjacent to the third cavity.

15

149. The method claim of 56, wherein the first geometric shape includes a base and first plurality of base edge lengths, wherein the second geometric shape includes a base and second plurality of base edge lengths, wherein the third geometric shape includes a base and third plurality of base edge lengths, wherein at least one of the base edge lengths of the first plurality is different from all of the base edge lengths of the second and third plurality of base edge lengths, and
20 wherein at least one of the base edge lengths of the second plurality is different from all of the base edge lengths of the first and third plurality of base edge lengths.

25

150. The method claim of 57, wherein the first geometric shape includes a base and first plurality of base edge lengths, wherein the second geometric shape includes a base and second plurality of base edge lengths, wherein the third geometric shape includes a base and third plurality of base edge lengths, wherein the fourth geometric shape includes a base and fourth plurality of base edge lengths, wherein at least one of the base edge lengths of the first plurality is different from all of the base edge lengths of the second, third, and fourth plurality of base edge
30 lengths, wherein at least one of the base edge lengths of the second plurality is different from all of the base edge lengths of the first, third, and fourth plurality of base edge lengths, and wherein at least one of the base edge lengths of the third

plurality is different from all of the base edge lengths of the first, second, and fourth plurality of base edge lengths.

151. A method of making a production tool, the method comprising:

- 5 creating a design for a production tool for manufacturing an abrasive article, the production tool comprising a plurality of cavities defined by substantially distinct and discernible boundaries which include substantially specific dimensions, wherein a first cavity has specific first dimensions, a second cavity has specific second dimensions, and a third cavity has specific third dimensions, each of said
- 10 cavities has a boundary defined by at least four planar surfaces wherein adjacent planar surfaces of one cavity meet at an edge to define an angle of intersection therebetween, wherein at least one angle of intersection of said first cavity is different from all the angles of intersection of said second and third cavities, and wherein at least one angle of intersection of said second cavity is different from all
- 15 the angles of intersection of said first and third cavities; and
- forming the production tool using the design.

152. A method of making a production tool, the method comprising:

- creating a design for a production tool for manufacturing an abrasive article,
- 20 the production tool comprising a first, second, and third row of cavities, wherein the cavities each have a geometric shape including a base and a plurality of base edge lengths forming the base of the geometric shape, wherein at least one of the base edge lengths of the first row of cavities is different from all the base edge lengths of the second and third rows of cavities, and wherein at least one of the base edge
- 25 lengths of the second row of cavities is different from all the base edge lengths of the first and third row of cavities; and
- forming the production tool using the design.

153. A method of making a production tool, the method comprising:

- 30 creating a design for a production tool for manufacturing an abrasive article, the production tool comprising first, second, and third cavities, wherein the first cavity has a first geometric shape including a base and a first plurality of base edge lengths forming the base of the geometric shape, the second cavity has a second

geometric shape including a base and a second plurality of base edge lengths forming the base of the geometric shape, and the third cavity has a third geometric shape including a base and a third plurality of base edge lengths forming the base of the geometric shape, wherein at least one of the base edge lengths of the first plurality of base edge lengths is different from all the base edge lengths of the second and third plurality of base edge lengths, and wherein at least one of the base edge lengths of the second plurality of base edge lengths is different from all the base edge lengths of the first and third plurality of base edge lengths; and forming the production tool using the design.

10